A Spatially-Explicit Individual-Based Model of YOY Yellow Perch and Walleye in Saginaw Bay, Lake Huron

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Early Life Survival

- Fast growth selected
- Size-based mortality
  - Predation
  - Starvation
  - Overwinter mortality
- Fast growth depends on
  - Environmental factors
    - Temperature
  - Prey availability

http://daphnia.cgb.indiana.edu/images/Daphnia_DGC.png

http://life.bio.sunysb.edu/marinebio/fc.chironomid.lind.jpg

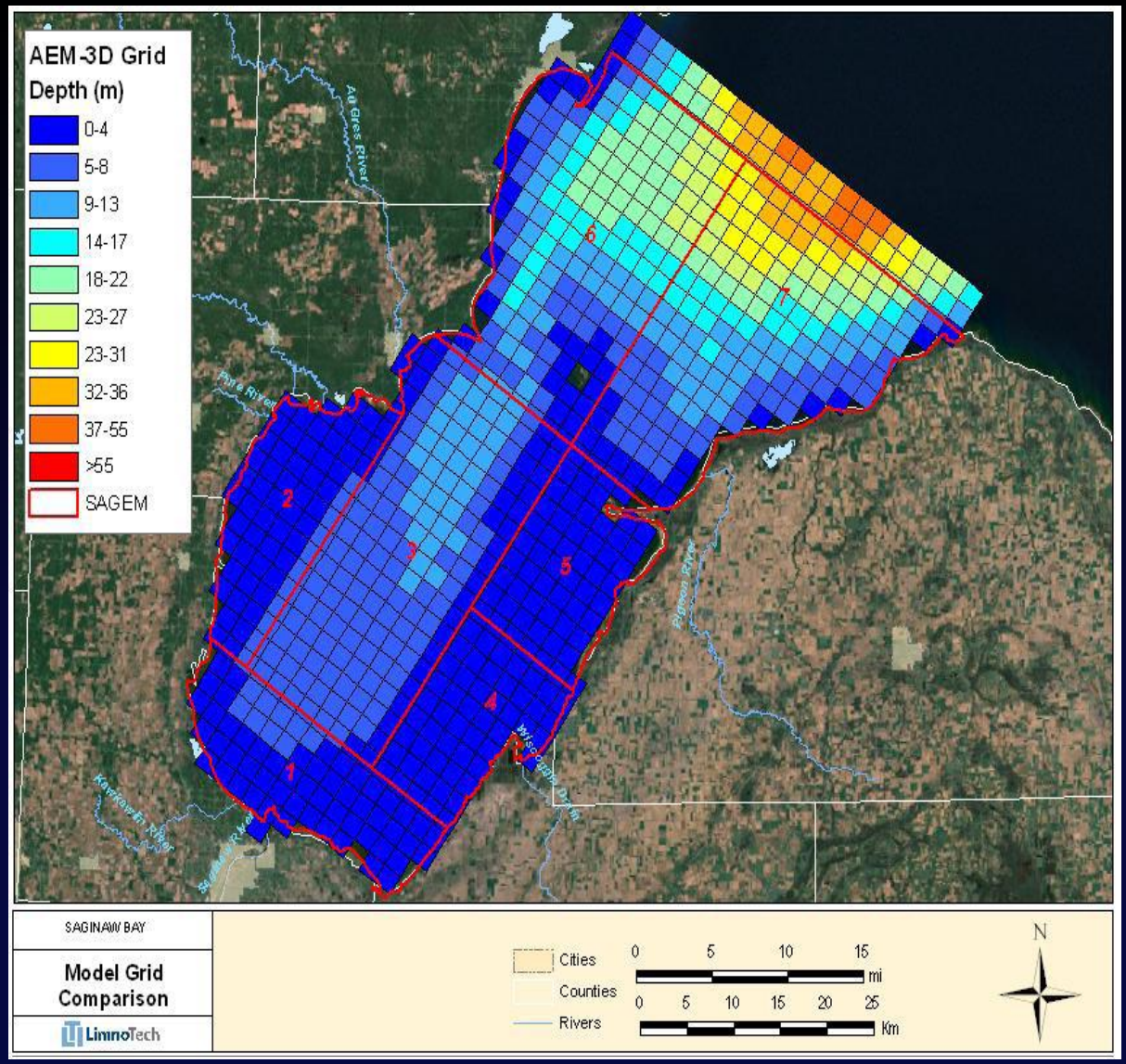
Objectives

- Develop a spatially-explicit IBM
  - Elucidate factors affecting walleye and yellow perch production
    - Examining 1st year of life
  - How changes in zooplankton and chironomids alter growth and survival of these 2 species

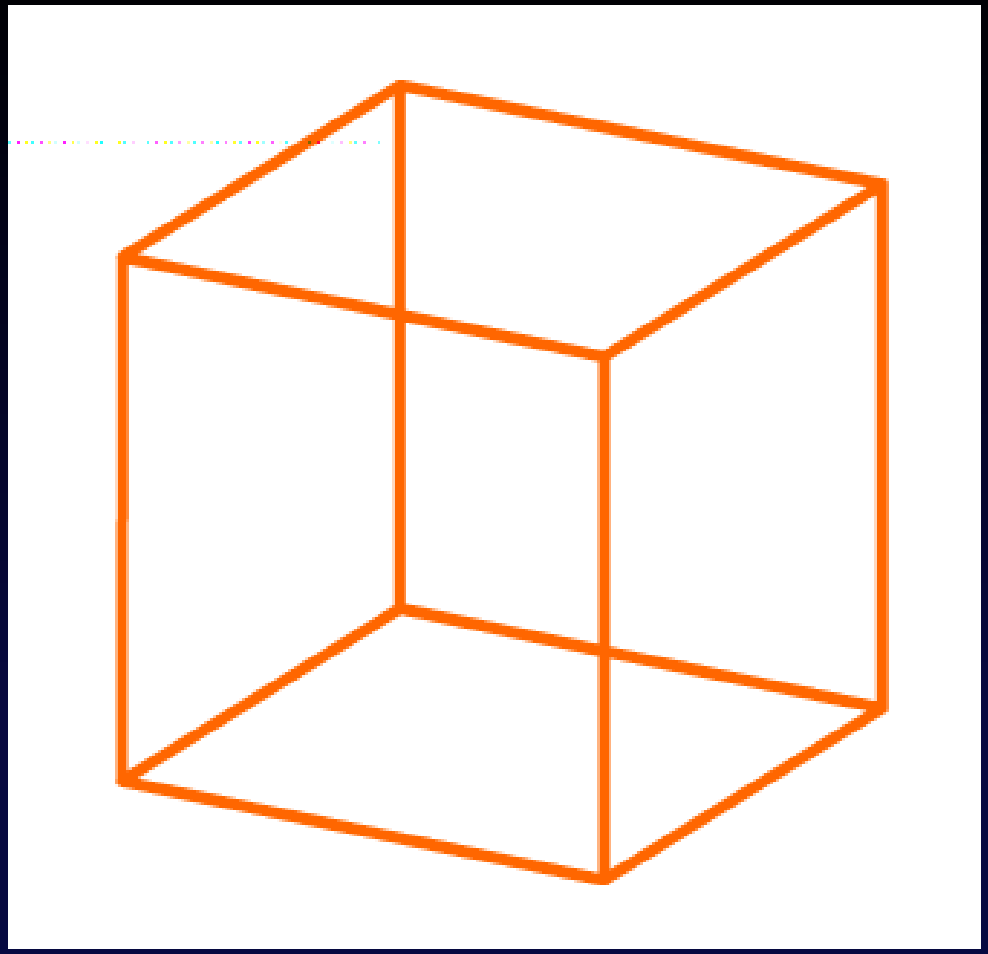
Model Design

- Coupled model
  - Limnotech developed a lower food web model
    - Hydrodynamics, temperature, light attenuation, DO
    - Algal groups
    - Zooplankton (3 size classes- Rotifers, Copepods, Cladocerans)
    - Dreissenid mussels

Model Structure



Model Environment

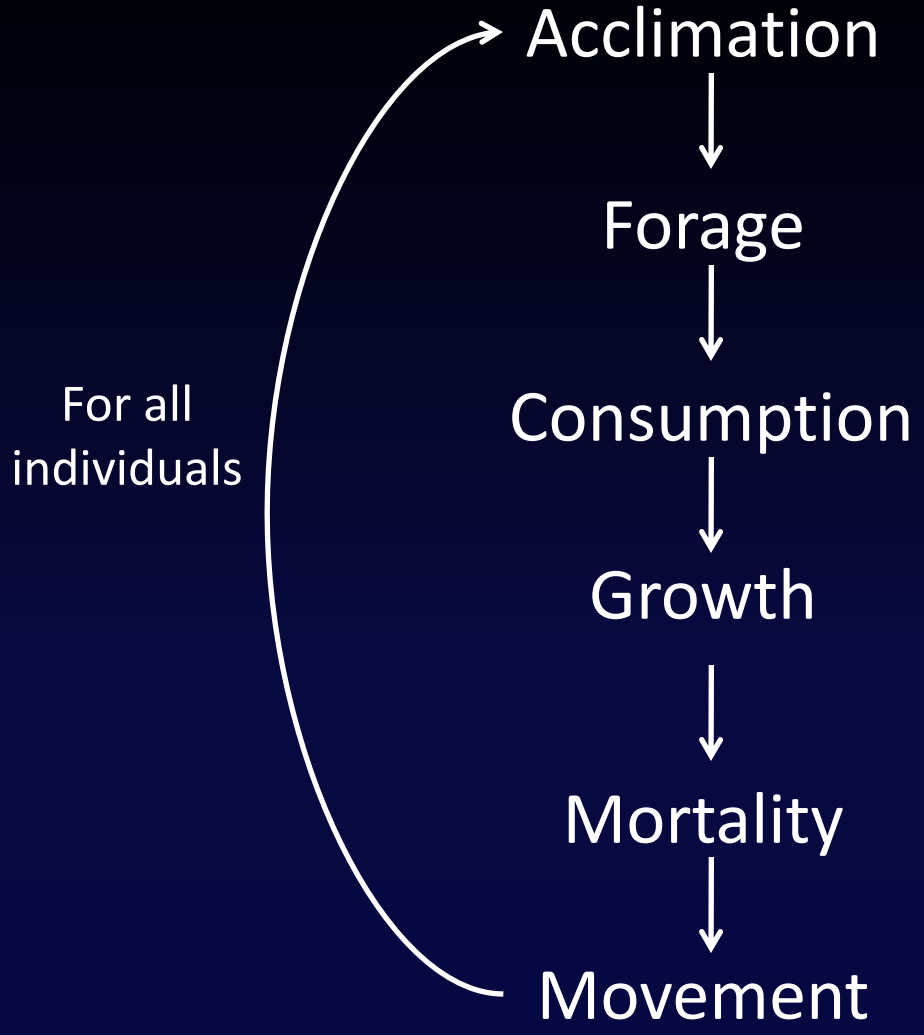


1. Temperature
2. Light levels (lux)
3. Carbon levels
4. Current directions
5. Prey density
    1. 3 zooplankton classes
6. Driessenids

Model Design

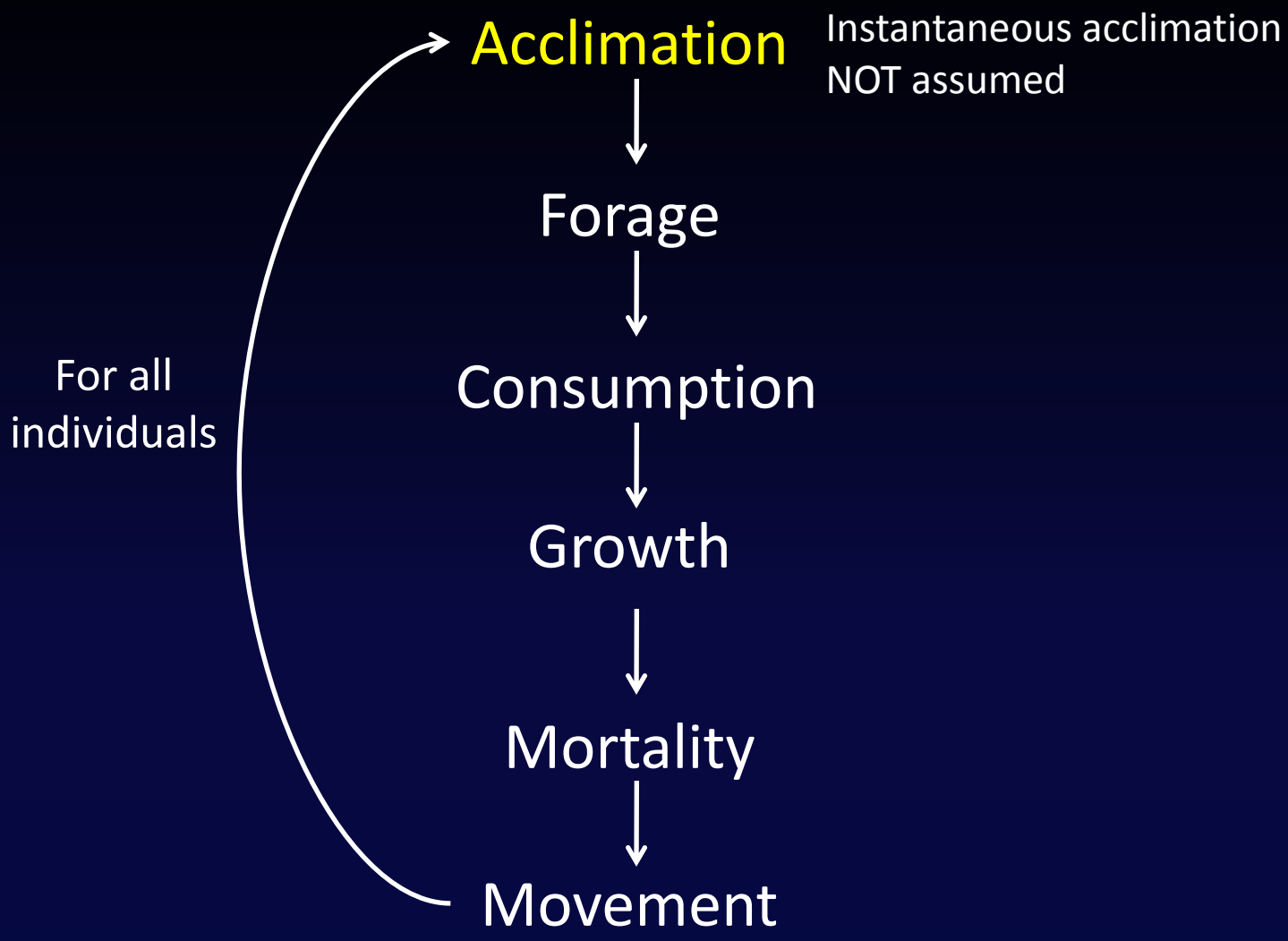
- Coupled model
  - Limnotech developed a lower food web model
    - Hydrodynamics, temperature, light attenuation, DO
    - Zooplankton (3 size classes- Rotifers, Copepods, Cladocerans)
    - Zebra Mussels
  - Spatially-Explicit IBM
    - Yellow perch and walleye
      - YOY
      - Modeled as superindividuals
    - Chironomids

IBM- Yellow Perch & Walleye

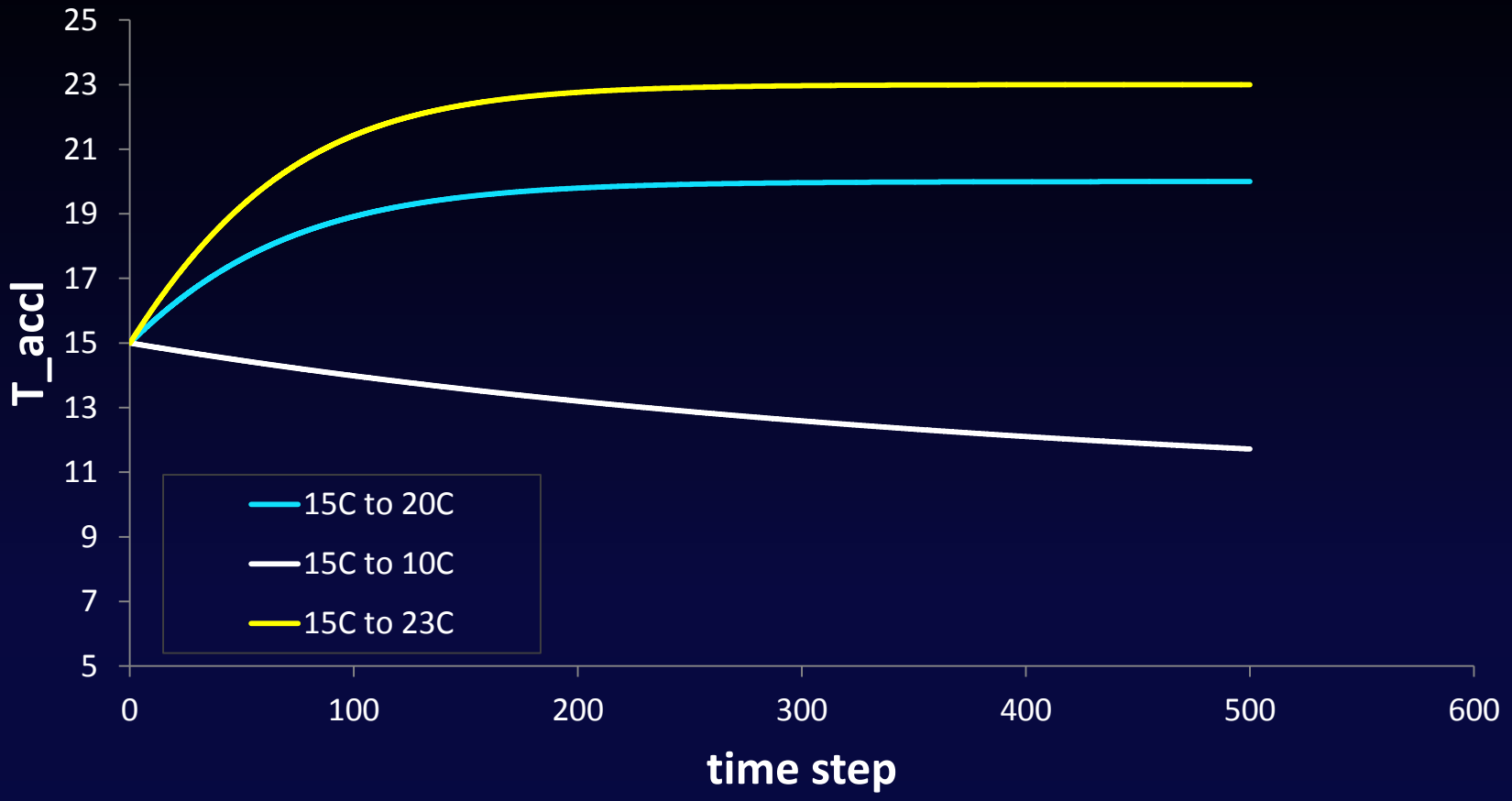


6 minute time step

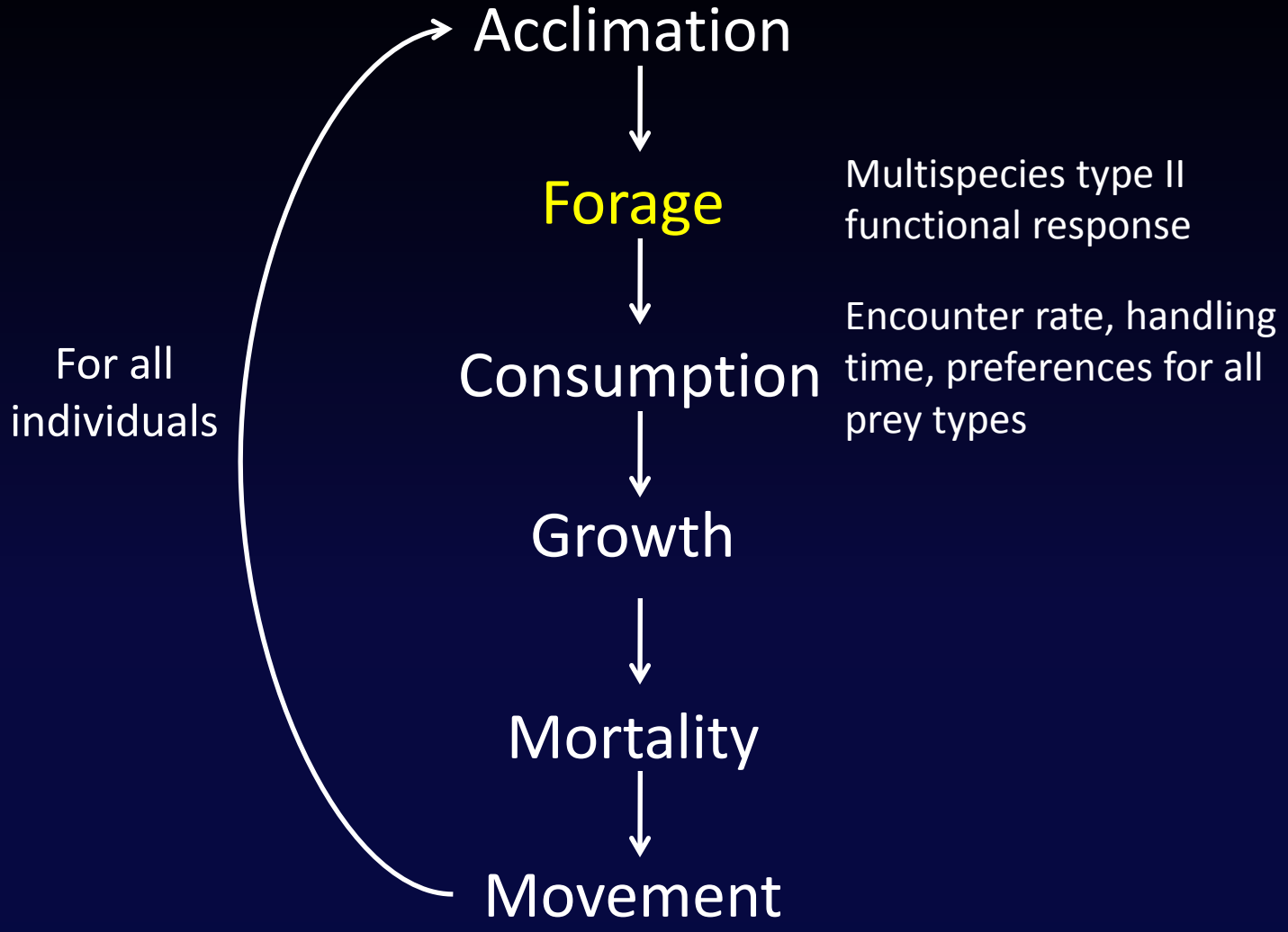
IBM- Yellow Perch & Walleye



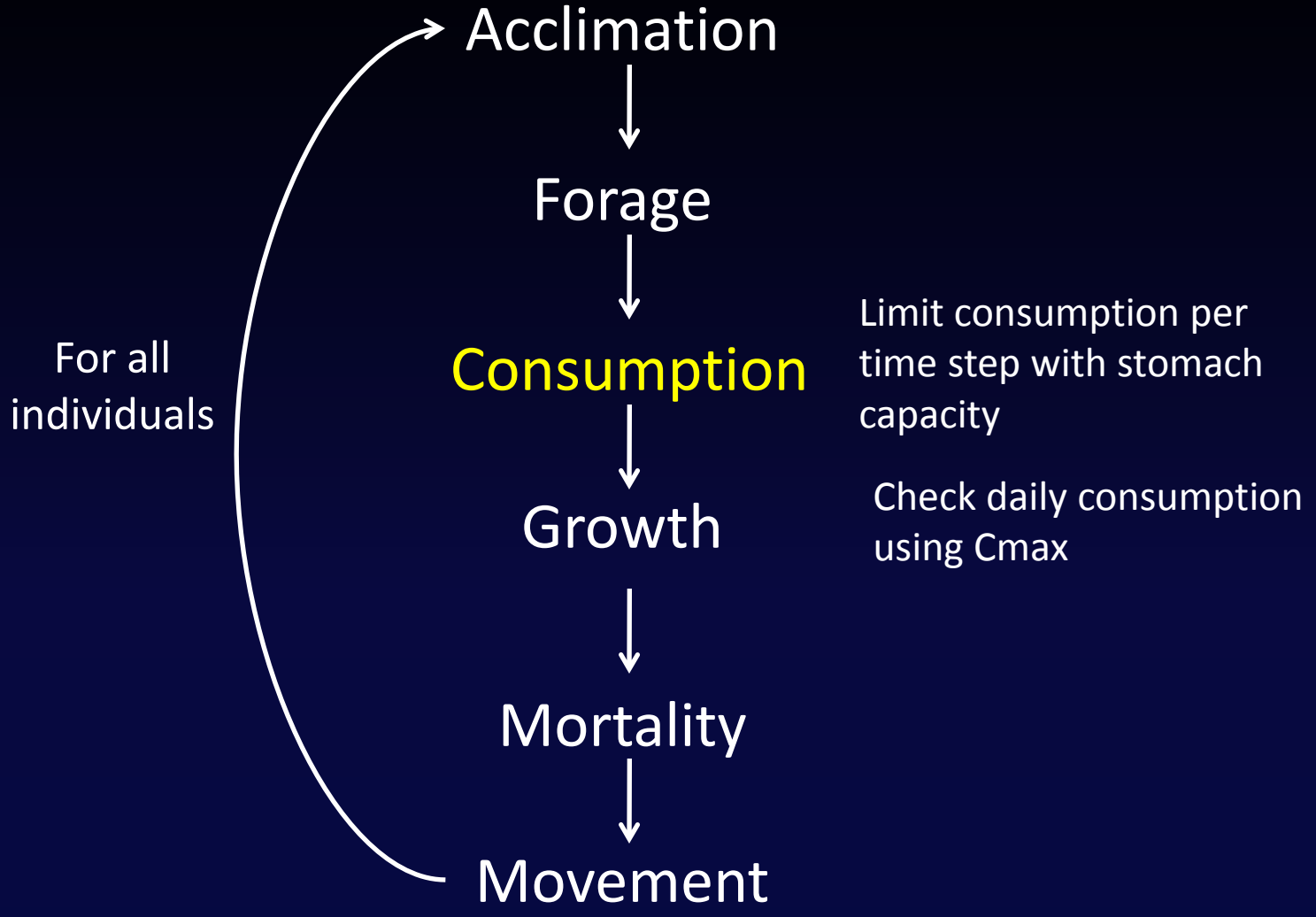
Temperature Acclimation



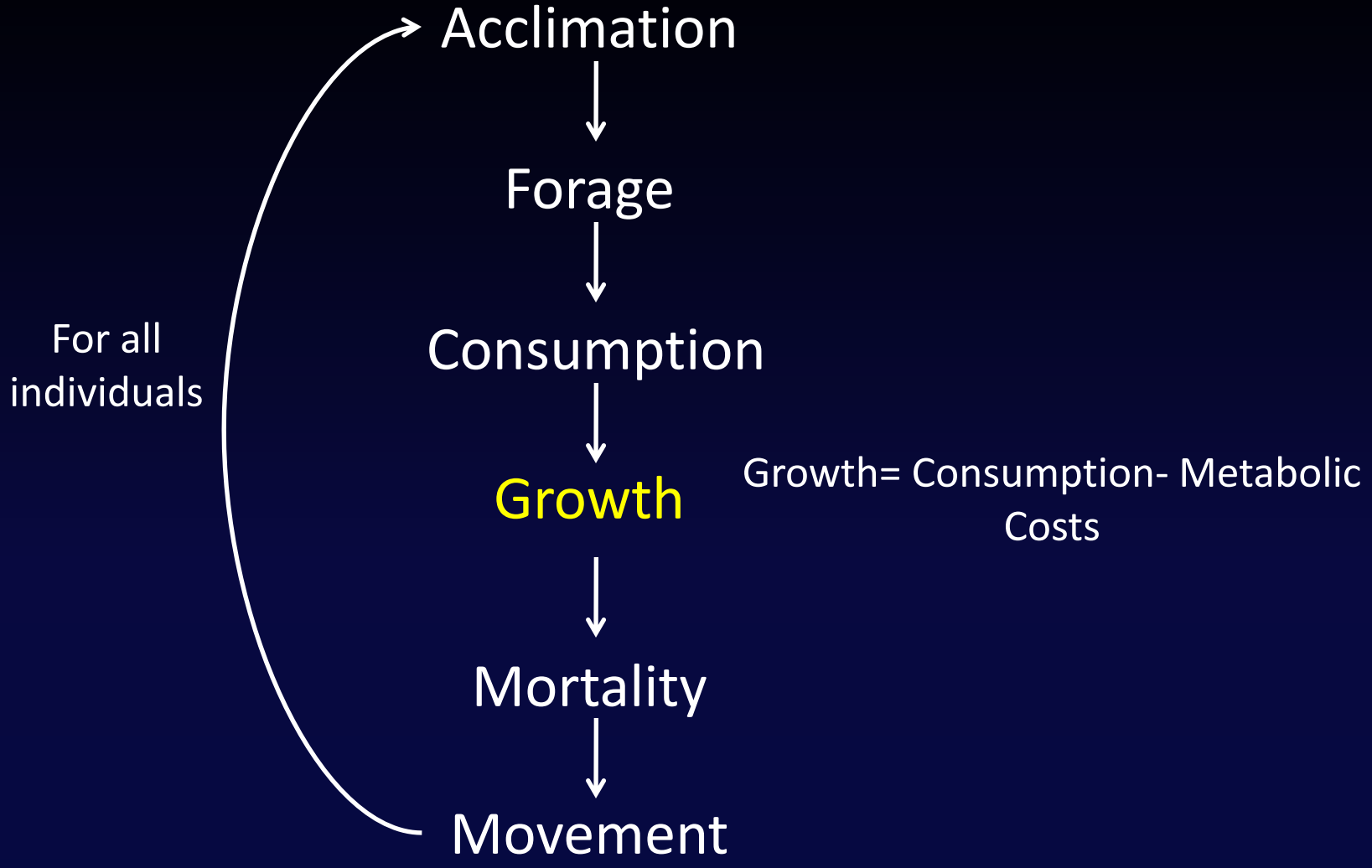
IBM- Yellow Perch & Walleye



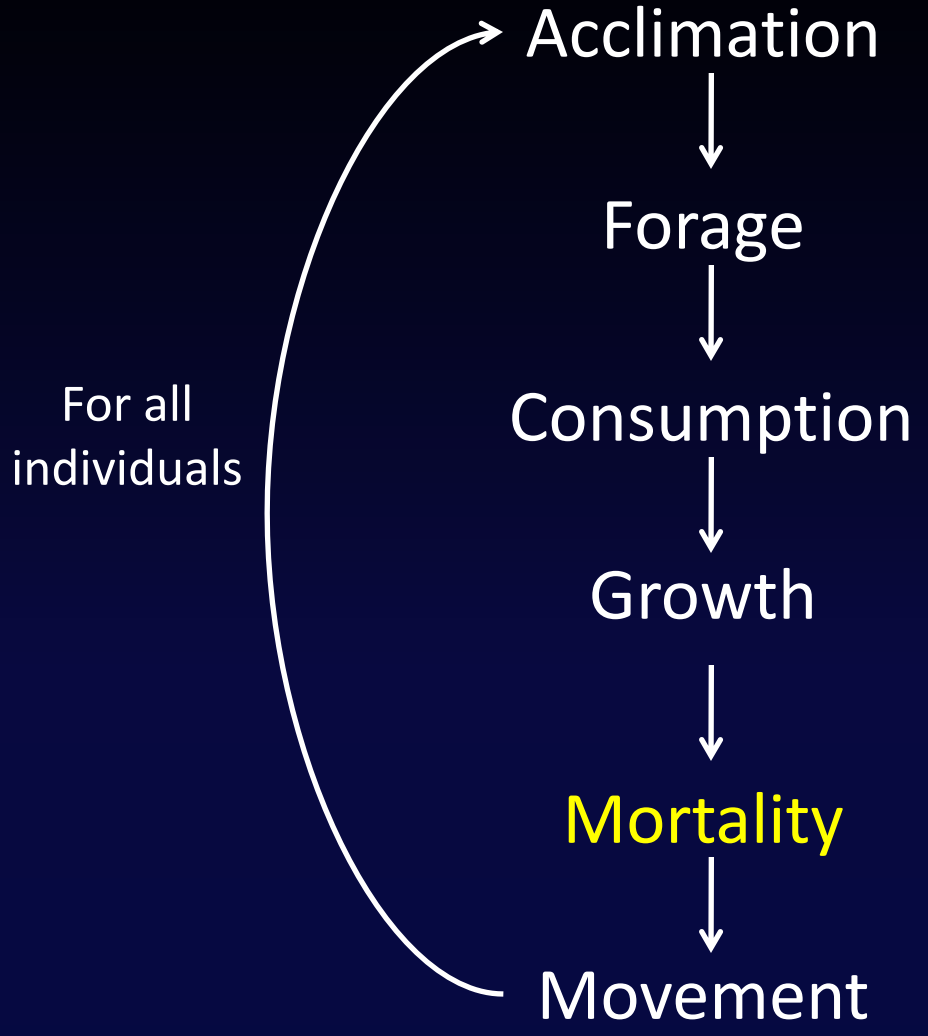
IBM- Yellow Perch & Walleye



IBM- Yellow Perch & Walleye



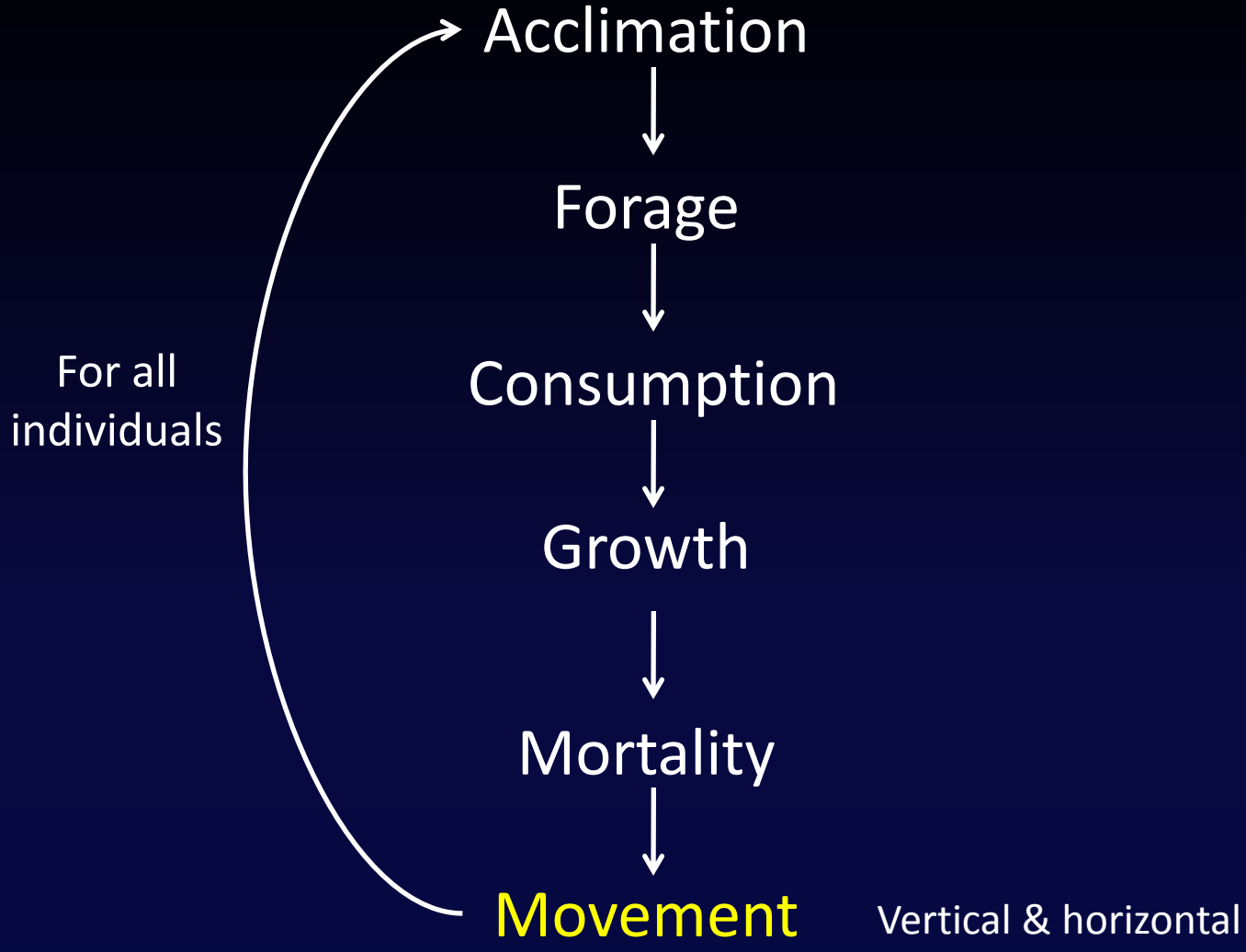
IBM- Yellow Perch & Walleye



Size-based predation mortality

Starvation mortality ratio of lipid to size

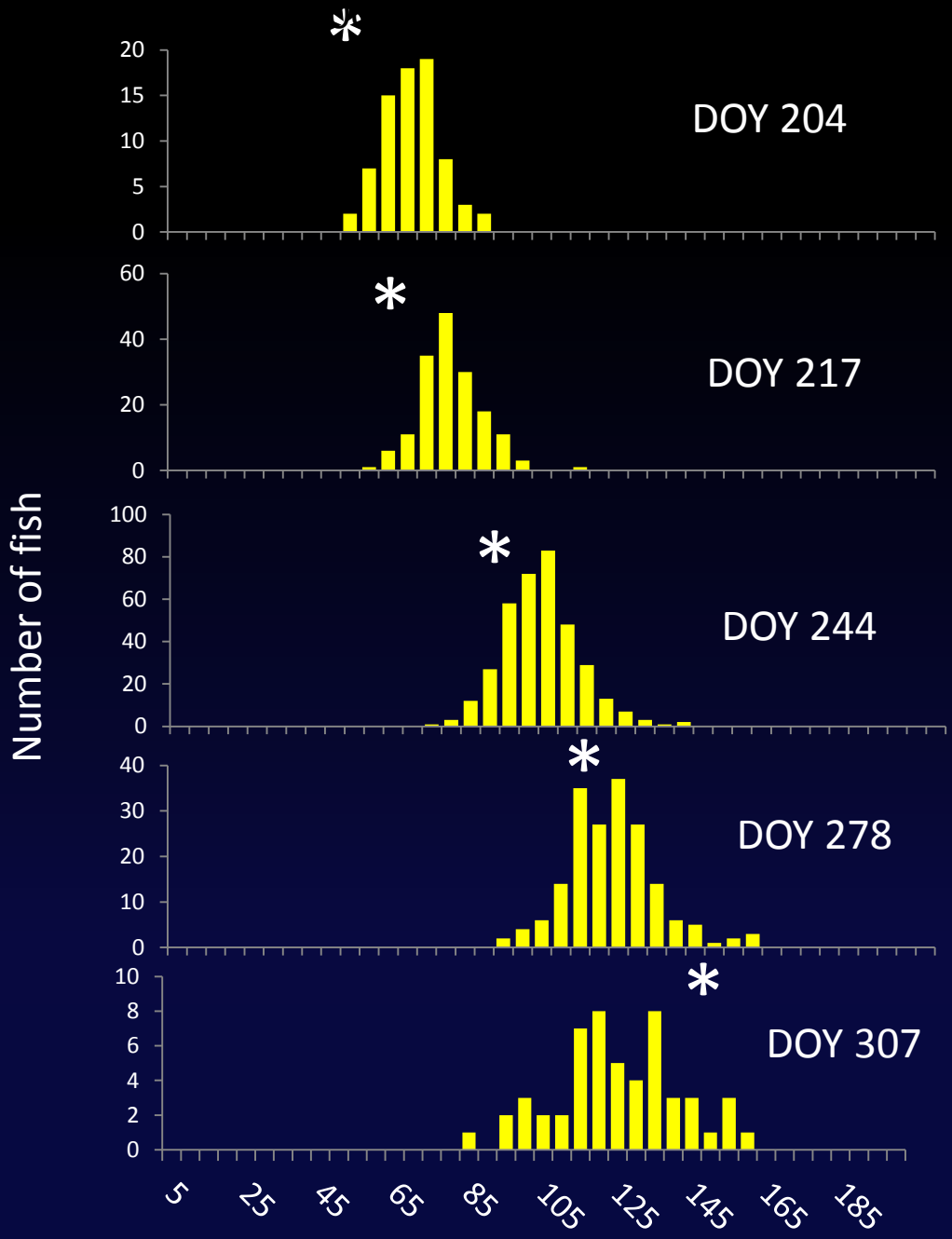
IBM- Yellow Perch & Walleye



Model Simulations

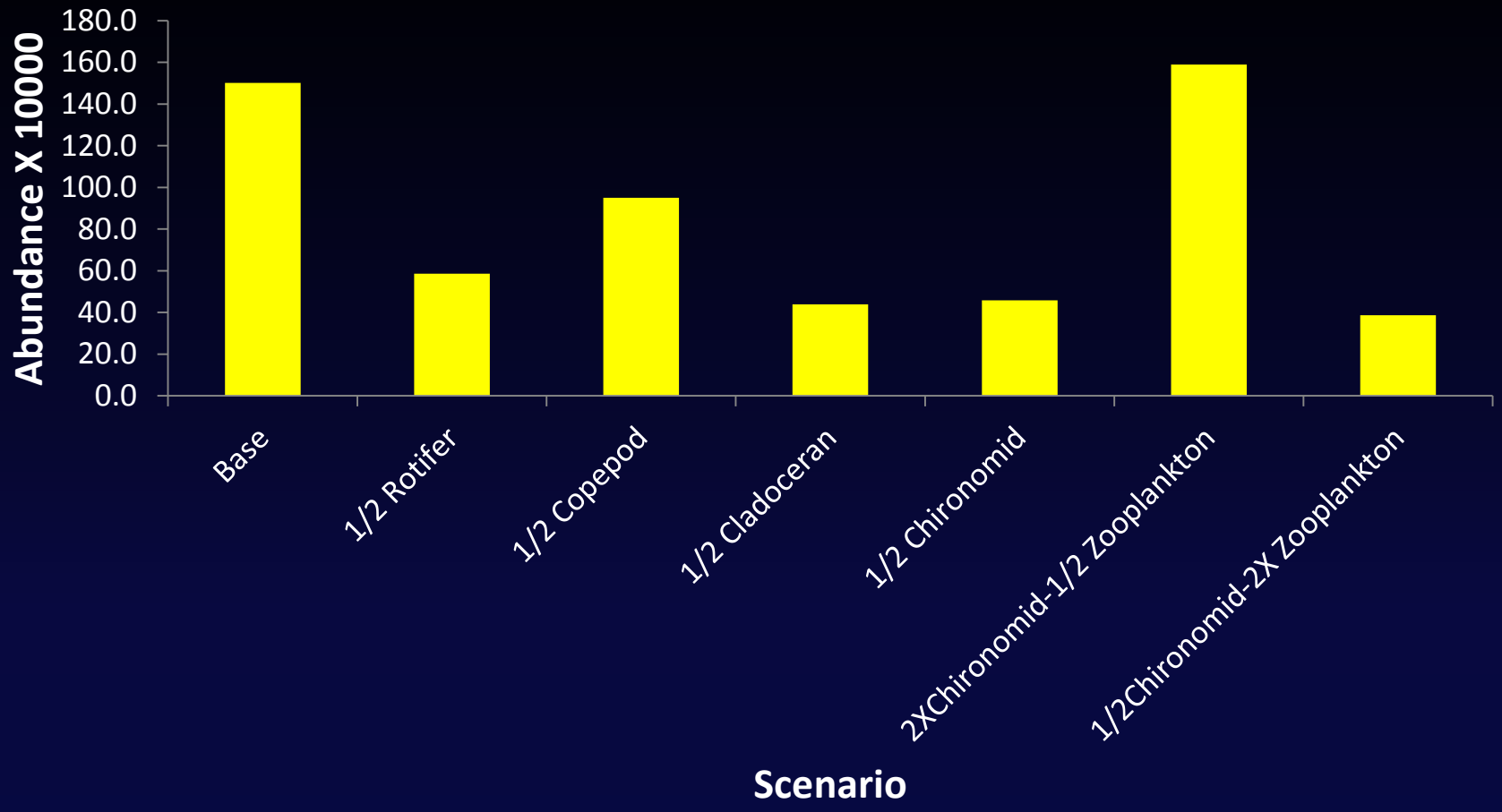
- Understand how prey availability affected growth and survival of yellow perch and walleye
  - Baseline Run
  - Decreasing zooplankton abundance
  - Decreasing chironomids
  - Increasing chironomids & decreasing zooplankton abundance
  - Decreasing chironomids & increasing zooplankton abundance

Calibration of model to walleye length frequency data from 2009

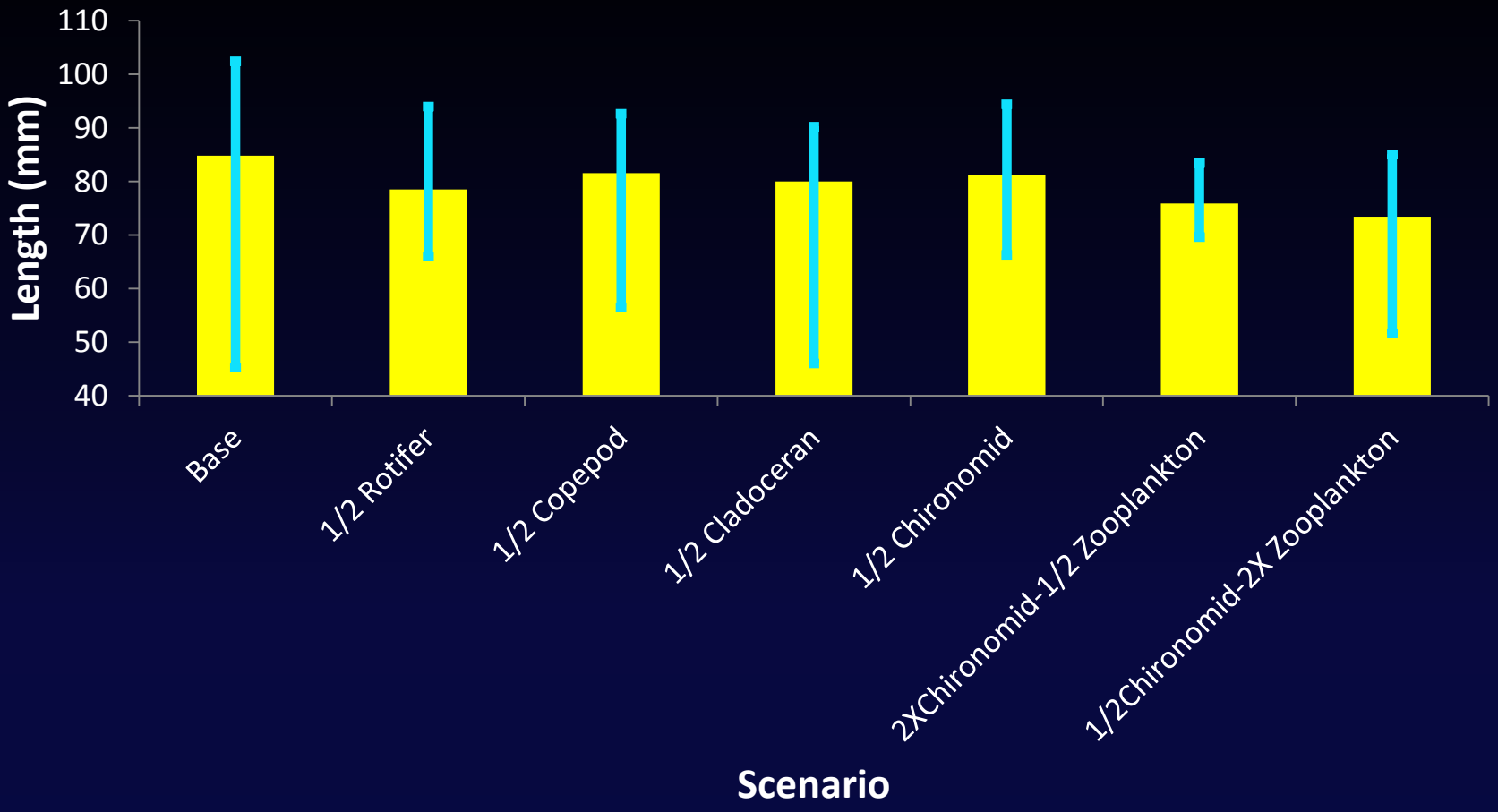


Data from S. Pothoven

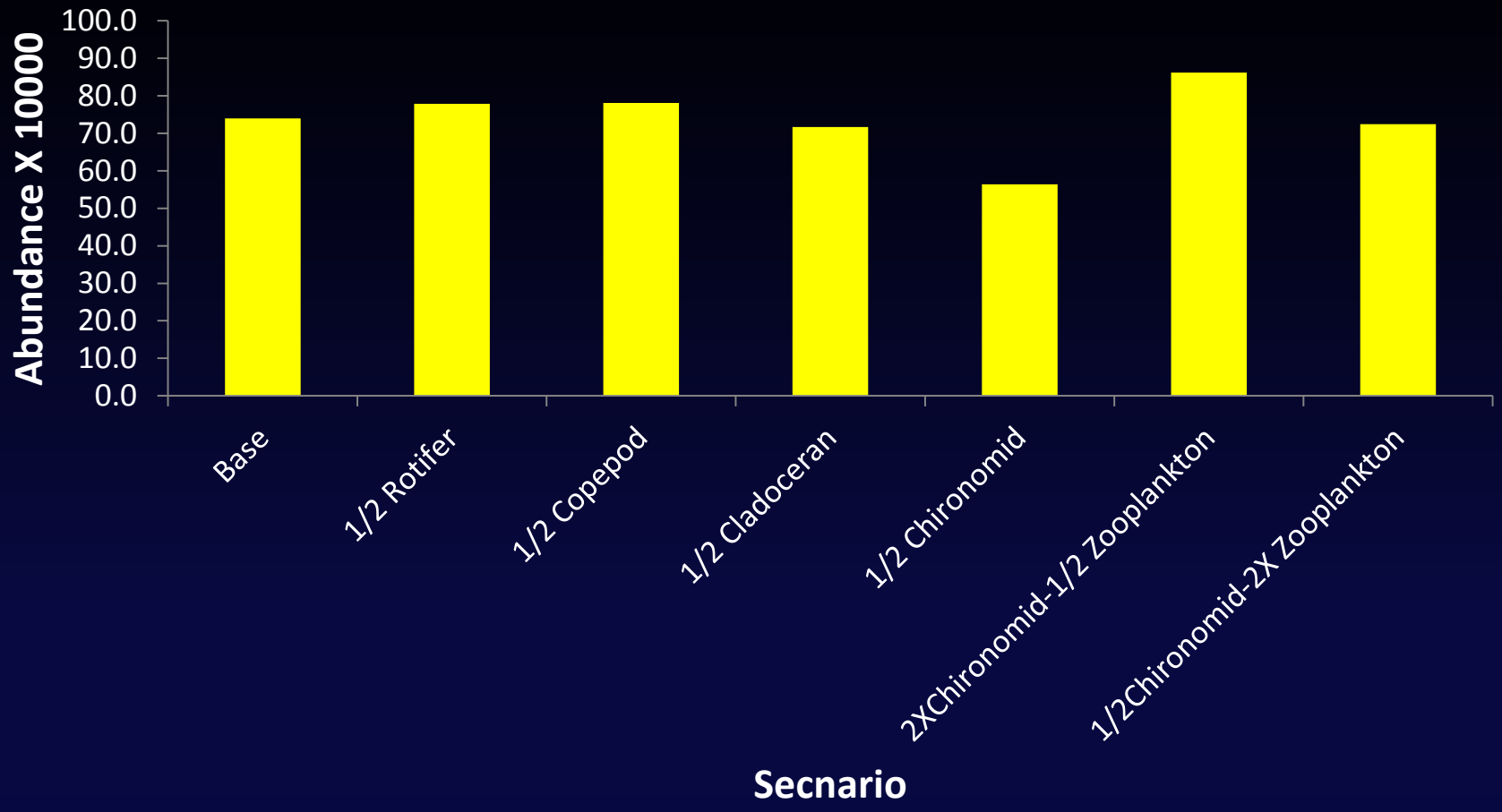
Yellow Perch Abundance



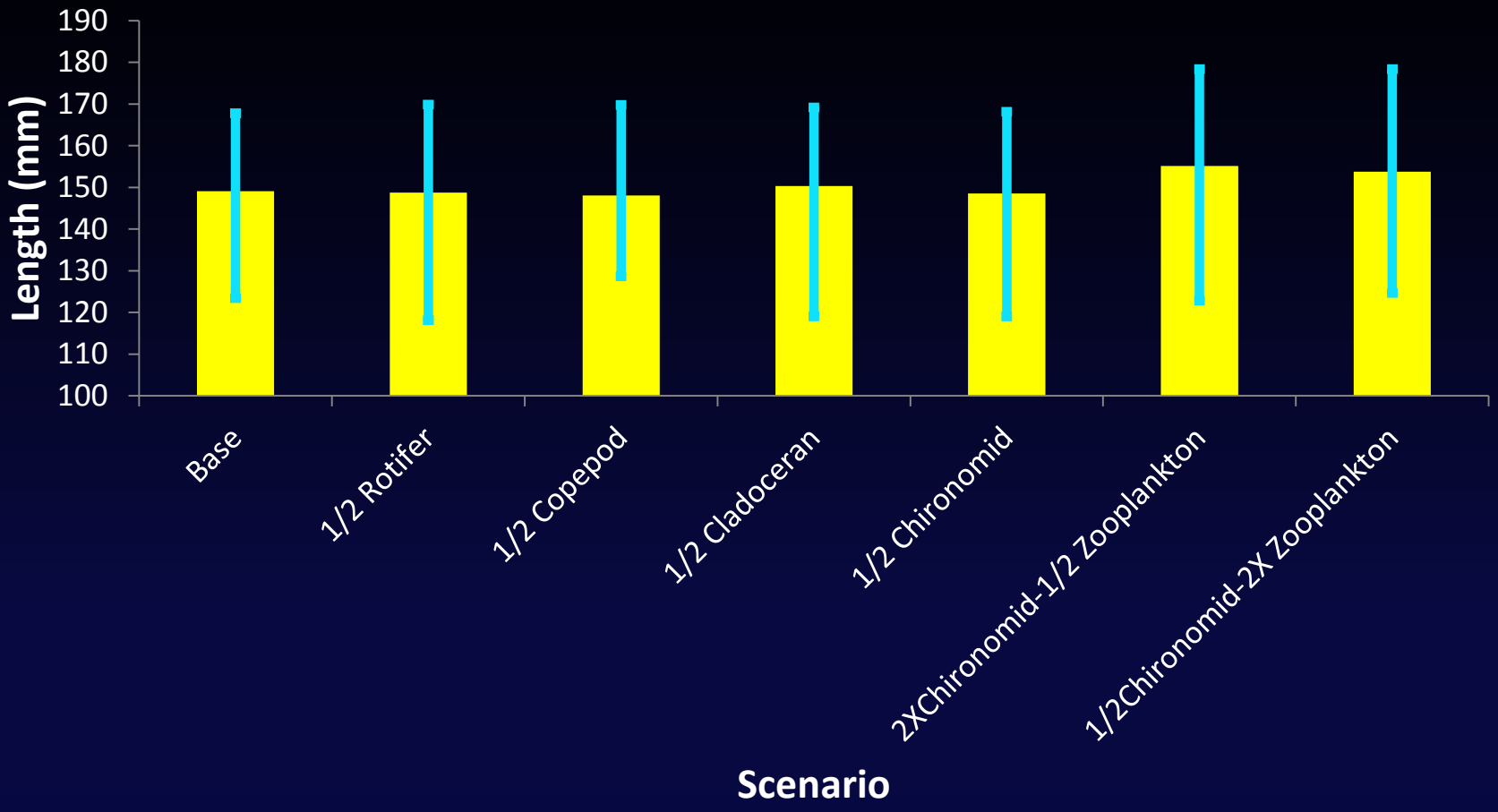
Yellow Perch Mean Length (mm)



Walleye Abundance



Walleye Mean Length (mm)



Conclusions

- Factors affecting yellow perch & walleye YOY abundance are complex
  - Yellow perch more impacted by prey abundance than walleye
- Little variation in mean length
  - Variability in yellow perch is greater than for walleye
    - A byproduct of space?
    - Superinderviduals

Future Work

- Modify movement rules
- Run simulations based on information from LimnoTech